# SCIENCE

FRIDAY, MAY 17, 1918

CONTENTS



MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

## THE VALUE AND SERVICE OF ZOOLOGICAL SCIENCE[1]

### VALUE TO THE INDIVIDUAL

THE science of zoology is a body of organized knowledge, huge, impersonal, influential. Touching human concerns on many sides, it has been variously regarded: now as a pillar of philosophy, now as a handmaiden of esthetic, or again as a necessity alike to spiritual progress and to various indispensable achievements in the practical world. Powerful in itself, to other disciplines its contributions of hard fact and substantial theory have been many and in the aggregate profoundly significant.

Philosophies, however, are the creations of philosophers. The laws that we apply to diverse aspects of beauty we have framed ourselves. Eugenics and medicine, agricultural practise and the dogmas of religion—all are the works of the human imagination. As attention shifts thus from the product to the producer, an aspect of zoology is revealed that makes at once a more intimately personal appeal.

It is on this aspect that I would now focus your attention. Its appeal is to the individual human being apart from his professional, his vocational existence: to the plain person, pricked by a thousand impulses that must be encouraged and controlled; attended by obligations that must be measured and met; with opportunities for pleasure that he would do ill to lose; with opportunities for service that may carry him unfaltering to the cannon's mouth; ready to see in commonplaces the

[1] Symposium before the Zoological Society of America, Minneapolis, December 29, 1917.

wonders that provide him with motives for action; who, in short, must accommodate himself to a real world by practising the absorbing art of living.

It may not be amiss to enter somewhat more concretely into the life of this every-day individual. For not infrequently in the past has a large portion of his innumerable and varied wants been slighted by a training dominated by a more limited professional ideal.

These wants may be divided, for convenience of treatment, into three groups. Of the first group little need be said. It concerns the upkeep and repair of the human mechanism. It comprises obvious wants that are supplied by well-known rules of hygiene and regimentation, by personal habits and ordinary common sense; by agencies for the production and distribution of the necessaries of life; by food and sanitary inspection; by physicians; by the growing round of organizations for social welfare that aim to care for the individual whatever he may do or be able to do for himself. The satisfaction of these wants comes thus in the routine of civilized life—a routine in which, it is unnecessary to point out, zoology plays an ample part.

In the second group may be placed the less obvious and immediate necessities of citizenship—opinions that must be formulated, judgments that must be made, actions that must be directed toward advantageous social and political ends. How will the voter decide such issues as meat inspection, vivisection, compulsory vaccination, sterilization of the unfit, commitment laws for mental defectives, treatment of criminals, prostitution, marriage? What appropriations will he advocate in support of measures for the public health, including the reportability of venereal diseases? What proportion of the community income will he wish to have expended for the schools? And what, indeed will be his ideas of the functions that the schools of his district should perform?

To such questions may be added others dealing with international intercourse, with the mixing of races, with the tremendous problems of making war and keeping the peace.

These are but stray samples of the manifold human interests that zoology touches firmly, inevitably. If there be teachers of zoology who dwell upon phases of the subject that are not wont to facilitate such implications as these, is it perhaps because the subject rather than what it may do for the individual is receiving the major part of their attention?

In the third group the wants are more subtle, intimate and personal than any thus far considered. Here belong what are called questions of principle and morality; the judgments of motive that must be made, the interpretations of conduct that must be risked, where facts are blurred and honest opinions differ. With these go a multitude of appreciations—of philosophy and art and out-of-doors—of spiritual values and economic results. For, in so far as zoology has contributed toward the development of sound theory in another field, will it be indispensable for the appreciation of that which it has helped to create.

Here we may consider also man's emotional life—his pains and pleasures, his predilections and prejudices, his indifferences, his peculiarities of behavior; and along with these, his countless individual adaptations to the changing conditions of social and family life, where understanding deserves an exalted station to which, in practise, it does not always attain.

There is no need to continue this enumeration of the problems which, sooner or

later, appear in the course of every normal human existence. Nor is it necessary to point out either their dominating importance or the fact that, in the efficient life, they must be met, frankly, successfully.

What is zoology able to contribute toward this end?

Our answer to this question will depend upon what we conceive zoology to be. Owing to the modern tendency toward specialization in the biological sciences, existing conceptions do not form a very compact and homogeneous mass. I shall not take time carefully to discriminate them, however; since they differ for the most part by limitation only. They exhibit varying degrees of incompleteness. One no longer expects morphologists and physiologists, taxonomists and experimental embryologists to agree on a common definition of their common subject. This may be a weakness of the professional attitude; or it may not. But a definition that will include all that these varieties of zoologist might severally propose, will be clear enough for the present discussion. At the same time, it will be sufficiently broad. Though common ground may not be occupied, common limits may thus be set.

Thus defined, zoology exhibits certain attributes that are possessed in common with the basic inorganic sciences, physics and chemistry; and certain other attributes that pertain in general to it alone. Like physics and chemistry, zoology is an organized body of facts and hypotheses developed by the inductive method, and safeguarded by processes of verification that become more rigorous and searching in each science as it develops. Like them, though in less degree, it is an experimental science; and aspires to a closer kinship with them by virtue of the recent increased interest in quantitative methods.

So far, the inorganic sciences and zoology are essentially similar. As soon, however, as the question of content arises, a significant difference appears. For the facts of zoology, though they rest ultimately on a physico-chemical substratum, present as a rule aspects so unlike the customary phenomena of the inorganic world as to produce far different effects upon the imagination. It is a truism that the imagination takes its color from experience. But it is none the less important because of that. Indeed, it is for this very reason that neither physics nor chemistry nor both together can be an adequate substitute for zoology as an aid in the solution of the diverse human problems that have been noted above. Man is an animal; one species among a hundred thousand; one living mechanism among countless millions, controlled by the same factors at bottom that control them all. These, however, are not generally recognized facts. For man is also a mechanism of a complexity that baffles his understanding and confuses his theories of control. Though himself a unit of the living world, his conduct appears to have been strangely free from the influence of a biological point of view. He has written treatises on philosophy that, exhibiting a commendable knowledge of Newtonian mechanics, commonly show no comparable sign of biological experience. His art criticism is as yet dominated by a literary tradition from which it only exceptionally frees itself by some innovation as refreshing as it is rare. Religion has always been slow to adopt the demonstrations of science, especially those that touch her traditions most intimately. Rules and dogmas readily usurp the functions of facts. This is amply true in the pedagogy of zoology itself. Real values here are still matters of varying opinion. The reason is in all cases essen-

tially the same. The differences spring from differences of imagination; which go back to differences of effective experience; which can be expressed, on the whole, in terms of relative ignorance.

One obvious avenue of relief from the general situation lies through the common schools. The inertia of tradition and the embarrassing difficulties inherent in the complexity of the human mechanism and its multiplicity of external relations can be advantageously attacked by beginning early in the individual life the development of a biological point of view. If facts are furnished, not withheld; if teachers recognize the persistent danger of standing between pupils and their wholesome interests; if children are permitted to think candidly about natural processes; if they are encouraged to appreciate the dignity of naked facts, to believe that it is no discredit to a fact that it is true; results will flow in the right direction.

Another avenue of relief that concerns us as college teachers more closely, lies through the courses of zoology, especially the general courses, that are being offered by our colleges. If the common schools accept their opportunities and responsibilities, ours are not thereby lessened. What are the functions of the colleges in this connection? What is the nature of the material that zoology offers them for their use? I shall consider the second question first.

In the first place, zoology offers facts that are of immediate practical utility in a thousand ways, facts that are associated commonly with the technic of vocations, and facts that are neither the one nor the other. There may be no fundamental differences between the facts thus classified. For the character of a fact can not be altered by the accident of its immediate applicability. In certain respects, however, the classes themselves differ. The first and second are small, specialized and circumscribed in comparison with the much larger, more diversified and expansive third. They make a more limited appeal to the imagination. They confine it, setting limits to its flights before it has tried its wings. For this reason, and this reason only, I contemplate with some reserve the recent mushroom growth of vocational courses in our secondary schools, with the substitutions they usually entail; although, regarded as protests against a certain detachment from the concerns of every-day life which zoology has been known to assume in the past, they possess merit.

However that may be, and however the facts themselves may be classified, as a whole they embody certain conceptions that are characteristic of organic as contrasted with inorganic science; for example, the living organism, growth, development, evolution, behavior, adaptability. These are all vivid, dynamic conceptions. They stress movement, change, the process rather than the result, the activities of organisms living rather than their architecture dead; in all cases, the reference of data to dynamic standards, such as the interpretation, for example, of structure in terms of function. Thus, a cat's leg, as a collection of bones and muscles, nerves and blood vessels, lacks the significance which as a living moving appendage it possesses. Yet it must be dissected if its beautifully coordinated movements are to be adequately appreciated. It must appear transparent to the mind's eye. Function and structure stand thus in an indispensable relation to each other. But there remains this difference between them, that while structures have no meaning apart from their activities, the latter apart from the former have meaning without significance. Physiology

and morphology necessarily march hand in hand; though I am of the opinion that for the fullest development of the interests of the individual, the former should set the pace.

In the second place, the facts of zoology fill a vast and varied domain that extends from physics and chemistry, on the one hand, to sociology and psychology, on the other. They concern life in its most elementary aspects and its most complex and subtle manifestations as well. They record the limits of our knowledge of the physiological mechanism, contributing at once to the analysis of the behavior of paramecium and the instinctive, even the rational life of man.

For purposes of intensive cultivation, this domain has been broken up into many subdivisions. All of these have prospered; in some cases to such an extent that, absorbed in their own immediately enticing concerns, their stewards have lapsed into a certain forgetfulness of their neighbors. This is a normal accompaniment of specialization. But it can hardly be said to be desirable either for the development of the science as a whole or for the individual who may chance to come within range of its influence. Such individuals there are, however, preparing in our graduate schools to teach zoology to the elementary students of the next generation: students of cellular biology, perhaps, who are frankly uninterested in animal behavior; or students of animal behavior to whom genetics is but a name; or students of genetics who neglect comparative anatomy; or comparative anatomists who care nothing for cellular biology. As special workers they will fit somewhere into the professional machine. As teachers of the future, they can promise the elementary student no more than they themselves possess. Which is a pity, when zoology has so much to offer.

In the third place, zoology is growing with great rapidity. It is a youthful science. The great mass of its resources are as yet undiscovered, though they lie everywhere about us. With a large and growing literature, its rewards are as yet not primarily for the bookish. They may be had by any alert and active mind. There is a fine democracy in the opportunity it offers. Its secrets may be bared by old or young. Though years of technical preparation are required by some types of problem, little or no technic is necessary for the solution of others that are well worth any one's trouble and time. The frontiers of zoology are constantly shifting. The written record is constantly being revised. This rapid growth brings movement, novelty, wholesome stimulation.

As a consequence, in the fourth place, zoology presents peculiar advantages to the elementary student in school or college, for the use of the constructive imagination. From the beginning he may develop his instinct for workmanship on problems that belong to the fabric of the world's work. From the beginning he may face issues that are not merely conjured out of his ignorance but are issues in the learned world as well. And he may contribute directly toward bringing them to an end. In zoology he may return to a wholesome apprenticeship as in the days when students were the assistants of their masters, shared their hopes and ambitions and felt the stimulus of their creative activity.

That is to say, he may if it is permitted. The subject invites, problems await him, problems that he can make his own and that thus stimulate the invention of methods, careful observations, discriminations of significant details in otherwise dead facts.

The subtle lure of discovery is here, and the dignity of personal achievement. The spirit of research is here, to transform the drudgery of soulless routine into the excitement of self-realization. High enthusiasms are here, moments of strong emotion and lofty aspiration.

This is all to be had, if it is permitted. There are reasons why it is not always permitted. Sometimes they are reasons of calculated educational policy, more often of administrative expediency. But what is of far more importance than the reasons to the individual student are the courses he is permitted to elect. It is profoundly unfortunate if he feels, on entering the zoological laboratory, that he has somehow lost his intellectual freedom, that he has been shorn of his initiative, that what is henceforth expected of him is a docile and orderly record of certain selected observations that he is directed to make.

Such cases occur, though exceptionally. That they do not occur more commonly is because the habit of docile indifference has already been acquired in the preparatory years. The pupil has frequently learned, like the Prussian soldier, to think by command only. He is ready to do what he is told to do. He is helpless when not told. He regards the instructor as a taskmaster, and the laboratory as a drill ground where his own responsibility is reduced to the minimum, where personal desires are of no practical value, but where it is useful, with a view to graduation, to be silent and obey.

We all recognize the deplorable type. Do we accept it? I am sure that we do not. For if we should, the little good that zoology might accomplish in the individual life under such circumstances would be negligible in proportion to the wastage that would surround it.

If we do not, what then?

One plan of action at least may be suggested of the many that are doubtless in practise among you. It would adopt all necessary measures to save the student's initiative, quicken his imagination, teach him the trick of invention, make a true researcher of him, if you will, in spirit. It would insist that each student regard the laboratory as his workshop where, with the facilities to be obtained there, he may think out and solve his own problems. It would set no conventional boundaries to the laboratory, which would best be considered the place where the student happened to be at work, whether in the college laboratory proper, or in the field, or at home. But it would stipulate that he do not come to the laboratory empty-minded; that he bring an inquiry that could best be investigated there, and that he develop the investigation with all due regard to care in observation, logic in thought, clearness and significance in record. The immediate environment would be the primary source of his material. Laboratory manuals would be limited to necessary technical directions. The classroom would serve for the discussion of principles, the formulation of problems, the criticism of results and the connection between it and the laboratory and the library be made as intimate and practical and workmanlike as possible.

In some such way the colleges might discharge a portion of their tacit obligation to place zoology in fullest measure at the service of the individual citizen, for the satisfaction of those wants that pertain to his personal life, whatever his vocational interests. Indeed, it is to the colleges especially that he must look for this help. For the colleges produce the teachers of zoology the country over. And the teachers touch the public with an intimacy of contact that is their privilege alone.

HARRY BEAL TORREY

REED COLLEGE